Network Control System

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The Network Control System (NCS) is being implemented for the Deep Space Network. This report includes progress activities for (1) final NCS hardware implementation, (2) NCS data formats and Mission Operations Control interfaces, (3) software development summary, and (4) interim NCS hardware and software development summary.

I. Introduction

This is the third report describing the JPL Deep Space Network (DSN) Network Control System (NCS). The previous reports (Refs. 1 and 2) described the project plan and resources, system functions and interfaces, data flow, and hardware allocations for the interim and final NCS configurations. This report describes progress toward implementation of the interim and final NCS.

II. Final NCS Hardware Implementation

The revised DSN 822-series System Requirements Documents are the basis for the NCS configuration which has been defined for hardware implementation. Detailed functional requirements documents and hardware block diagrams are in preparation for subsystems with approved configuration and budget.

Extensive effort has been directed to design maximum uniformity into the mini-computer subsystems. This design includes processors, memory, input/output, communication link interfaces, peripherals, NCS standard data transfer interfaces, direct memory access, operating modes, and on-line/off-line spares compatibility. An automatic data processing equipment (ADPE) plan has been prepared and approved for the NCS subsystem minicomputers.

A reassessment of budgets and functional requirements has delayed procurement of the Network Support Controller midi-computer. The support functions, of diminished scope, will be provided by two Sigma 5 computers transferred from the interim NCS. Additional memory and functions will be required above that provided by the interim NCS Sigma 5 configuration.

The development of a standard data transfer interface for computers and peripherals, to reduce related obsolescence costs when selected equipments are updated, has been a DSN goal. Various interfaces have been evaluated for NCS/DSN standards. The NCS data interfaces are:

(1) NASCOM GCF, 1200/2400-bit serial data block.
(2) RS232, serial ASCII.
(3) Standard parallel byte, 8 bits with 6 control lines.

The byte format provides efficient computer-to-computer controlled transfers, adaption to common data processing peripherals, optimum interface to a Bus Switch Controller (BSC), and data transfer rates well in excess of current requirements.

The BSC is a hardware device for multiple-port data routing between various NCS computers. The BSC configuration will provide routing priorities, subsystem functional addressing, computer-controlled data transfers, and multiple-path full-duplex data routing. The hardware will be of modular configuration to provide cost-effective implementation of the same basic unit in several NCS computer interfaces.

The Display Subsystem requirements for the final NCS have been revised, and will be implemented in a stand-alone configuration. Features include improved data selection modes, hard copy, simplified video distribution, and higher reliability at reduced cost.

The Network Control System to Mission Control and Computing Center (NCS to MCCC) communications link provides for bilateral transfer of operations and administrative data, and for NCS Ground Communications Facility (GCF) log recall to MCCC. The NCS/MCCC link can be switched for backup to several of the existing GCF lines from Central Communications Terminal (CCT) to MCCC. The MCCC interface to the NCS is the same as to a DSS and requires no MCCC hardware implementation.

The NCS will provide for the operation of a Remote Mission Operations Control (RMOC) for project control to a DSS. The data path via the NCS GCF filler multiplexer will provide NCS access to the high-speed data line (HSDL) synchronized by the RMOC data set. The GCF filler multiplexer will synchronously substitute local NCS data blocks for GCF filler blocks on the line from RMOC to DSS. The GCF filler multiplexer will be used in conjunction with the normal GCF equipment as shown in Fig. 1.

III. Final NCS Software Development

The software design effort for the final NCS has involved extensive negotiation and interpretation of implementation details related to the basic functional requirements. Overall software system block diagrams have been completed. Detail Software Requirements Documents, including diagrams and detail functions, are in preparation and review for each NCS subsystem. Project reviews are in progress to establish accuracy and uniformity of common elements. In addition, benchmark test criteria have been generated to evaluate mini-computer features applicable to all the NCS subsystems. They include:

(1) Linking and addressing.

(2) External interrupt characteristics.

(3) Word synchronization.

(4) Macro algorithm computation time.

(5) Operating system priority features.

(6) Fortran alpha-numeric manipulation.

(7) Accuracy and execution time of calculations.

(8) Fortran compiler evaluation.

(9) Bit, byte, word, doubleword, manipulation.

(10) Direct memory access data transfers.

A contract for software design support for the final NCS has been negotiated. Contract start time is estimated to be early March 1973.

A computer model study has been implemented to evaluate line loading, processing, and memory requirements as applied to the CCT Communications/Log Processor (CLP). This processor, with attendant input/output and data logging, is being reviewed for its stringent functional requirements and associated memory requirements.

IV. Interim NCS Hardware Implementation

The interim NCS will provide selected control and monitoring functions for the DSN from July 1973 to July 1974. These functions will be provided by the realtime and backup Sigma 5 computers described in the previous DSN progress report.

The interim system will be installed in JPL Building 202 as shown in Fig. 2. The facility has an existing raised floor for interequipment cabling. The realtime Sigma 5 processor, printer, seven- and nine-track magnetic tapes, paper tape reader/punch, teletype, disk memory and card reader are installed, tested, and being used for software development. Remaining operator terminal display, communications controllers, and remote line printer are scheduled for installation in March. The complete backup Sigma 5 equipment will be installed in May 1973.

The PDP-8 input/output equipment is temporarily located in Building 202 to facilitate testing with the Sigma 5. Interface buffer circuits for two GCF channels have been fabricated and are being tested with the PDP-8. The line drivers, data sets, and data lines for communication between Buildings 202 and 230 have been delivered and are in test.

The NCS to MCCC high-speed data (HSD) link will be implemented for the interim NCS with functional interfaces as described above for the final NCS.

The interim NCS will also provide for operation of an RMOC with a GCF filler multiplexer as described above for the final NCS. The logic design is complete, and two prototypes of the GCF-FM are being fabricated at JPL for use in the interim NCS.

V. Interim NCS Software Development

The software design for the interim NCS is based on an approved subset of the final NCS JPL 822-series functional requirements documents.

Preliminary analysis has shown the need for additional memory in the Sigma 5. An ADPE plan has been approved and procurement is being expedited. The system software block diagram and requirements document have been completed. Subsystem detail requirements and software design are in progress.

Software design personnel, provided by a support contract, are assigned to support the JPL subsystem task leaders. Project design reviews have facilitated uniformity of subsystem design, applicability to final NCS, requirements revisions and guidelines, and expedited schedule milestones.

References

1. Hall, J. R., "Network Control System," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. XI, pp. 5–11. Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1972.
2. Edwards, J. N., "Network Control System," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. XIII, pp. 209–218. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1973.

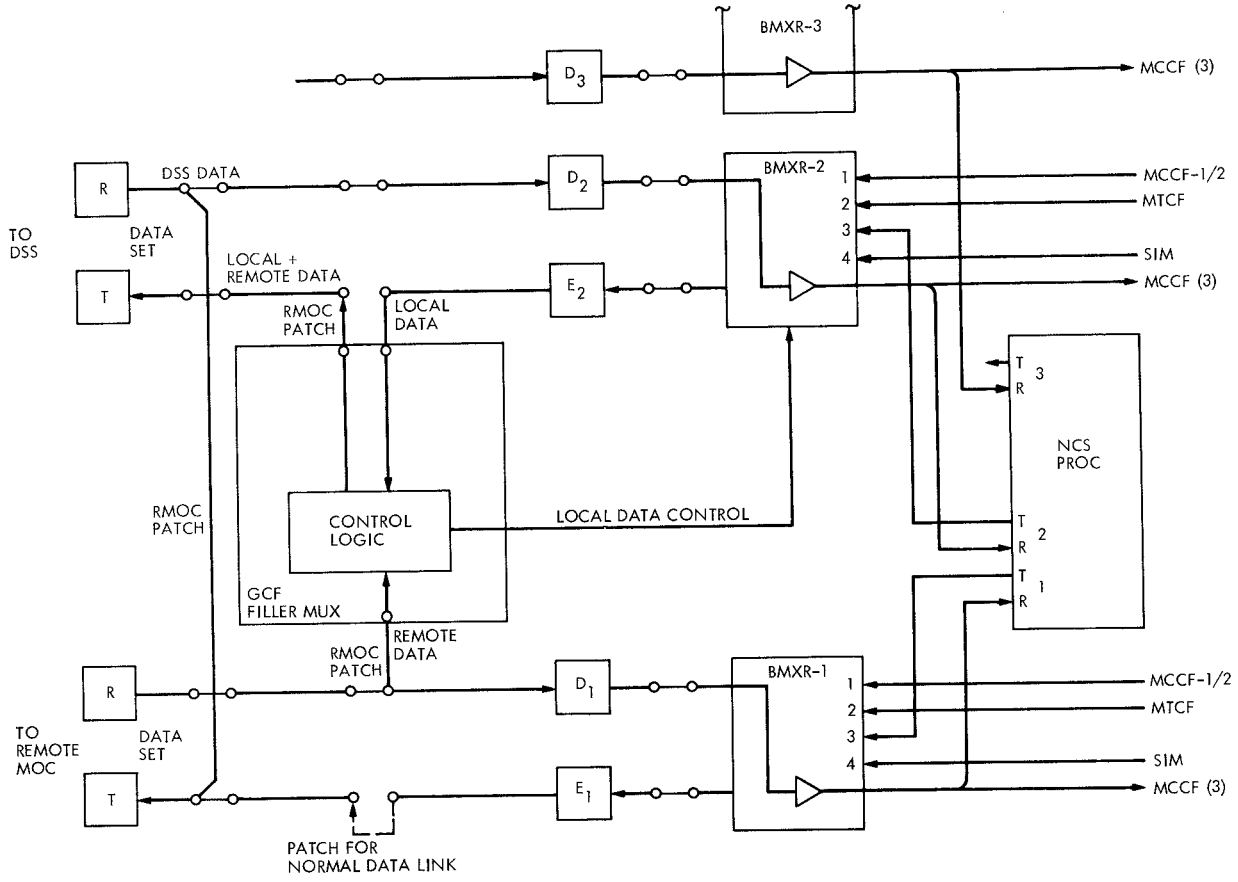

Fig. 1. NCS/Remote Mission Operations Control link

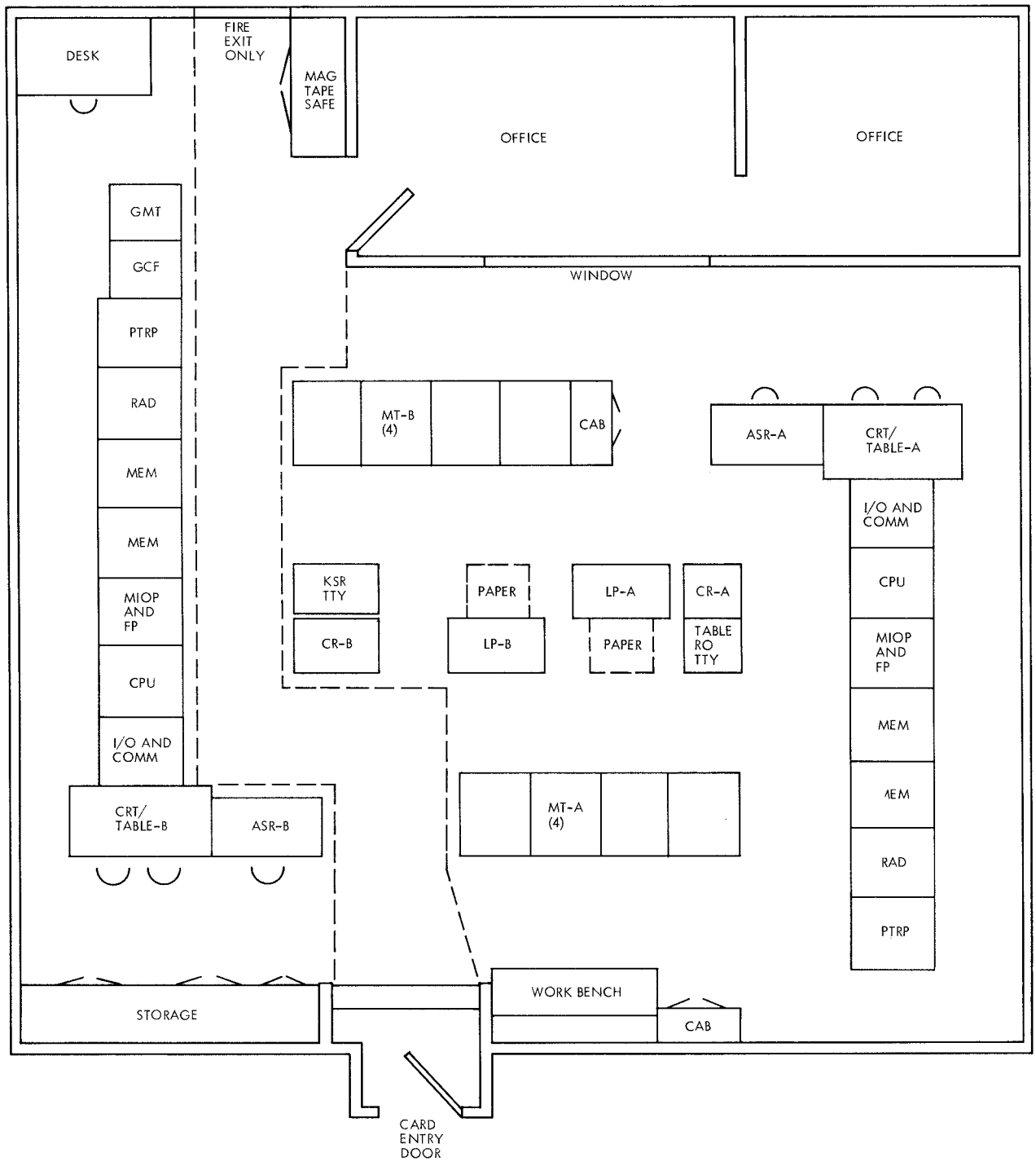

Fig. 2. Interim NCS data processing area